Facts At Your Fingertips

Atmospheric Storage Tanks: Roof Classifications

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Storage tanks that are freely vented to the atmosphere are known as aboveground atmospheric storage tanks (ASTs). ASTs have a vertical cylindrical configuration and can be identified by the open vent nozzle on the tank roof. This one-page reference outlines the classifications for ASTs based on roof type, and provides information on tank construction.

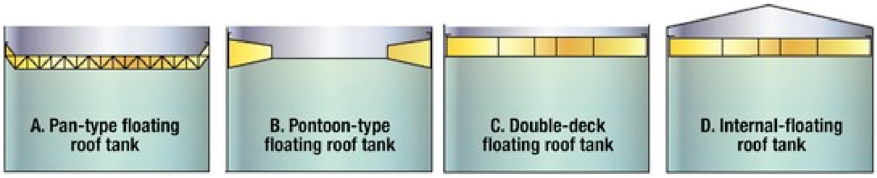
A. Pan-type floating roof tank
B. Pontoon-type floating roof tank
C. Double-deck floating roof tank
D. Internal-floating roof tank

FIGURE 1. Types of floating-roof tanks include the following: A) pan; B) pontoon; C) double-deck floating roof tank; and D) internal-floating roof tank [*1*]

Tank roof types

Two basic types of vertical-tank roof designs exist — fixed or floating roof.

Fixed roof. In this design, the tank roof is welded, and the shell and the roof remain static. Fixed-roof tanks consist of a cylindrical shell with a permanently welded roof that can be flat, conical or dome-shaped. As a rule of thumb, fixed-roof tanks are used to store liquids with true vapor pressures (TVP) of less than 10 kPa (absolute) [*2*]. TVP is the absolute pressure when the vapor is in equilibrium with liquid at a constant temperature.

Floating roof (internal or external). In this design, the tank roof floats on the liquid surface and rises and falls with changes in liquid level. These tanks reduce evaporation losses and control breathing losses while filling. Floating roofs are preferred for tanks storing petroleum products with a TVP of 10.3 to 76.5 kPa absolute. For liquids with flashpoint below 37.8°C, excessive loss of volatile liquids occurs from the use of open-vented fixed-roof tanks. Hence, floating roofs are mostly used for liquids with flash points below 37.8°C [*2*]. Flashpoint is the lowest temperature, (corrected to a barometric pressure of 101.3 kPa(a)) at which application of a flame test causes the vapor of the test portion to ignite under the specified conditions of the test.

The internal floating-roof tank (IFRT) has a permanent fixed roof with a floating roof inside, while the external floating-roof tank (EFRT) consists of an open-topped cylindrical shell with a roof that floats on the liquid. There are principally three different types of external floating roofs (Table 1) along with the internal floating-roof tank (Figure 1). IFRTs are preferred in areas of heavy snowfall, where accumulation of snow or water on the floating roof may affect buoyancy. In such tanks, the vapor space is normally blanketed with an inert gas [*1*].

In an IFRT, tank vapor space located above the floating roof and below the fixed roof includes circulation vents to allow natural ventilation of the vapor space. This action reduces the accumulation of product vapors and possible formation of a combustible mixture [*2*].

TABLE 1. TYPES OF FLOATING-ROOF TANKS [*1*]

Type	Characteristics
Pan-type roof	• Single-deck roof • Full contact with liquid surface • Has a deck, hence any leak through the deck will cause it to sink • Has no buoyancy other than that provided by the deck • Rain or snow may cause deformation • Is the least expensive of the floating roofs
Pontoon-type roof	• Increased buoyancy and stability • Pontoons occupy about 20–40% of roof area
Double-deck roof	• Comprises upper and lower decks separated by bulkheads and trusses • The space between the decks is separated into liquid-tight compartments • Superior loading capacity • Recommended for tank diameters below 12 m and above 60 m

Physical criteria

ASTs may be shop-welded or field-welded and are customarily fabricated from structural quality carbon steel, such as A-36 or A-283 Gr.C. [*2*] The vertical cylindrical shape and relatively flat bottom helps to keep costs low. Typically, ASTs are considered to have an operating pressure ranging from 0 to 0.5 psig. Tanks designed to operate at pressures between 0.5 and 15 psig are termed as low-pressure storage tanks. Designs above 15 psig are treated as pressure vessels.

Tank capacity. Three different types of tank capacity are defined — nominal, gross and net capacity. For fixed-roof tanks, the nominal capacity is the geometric volume from the bottom of the tank up to the curb angle, which is a metallic angle that is welded along the periphery at the top of the cylindrical portion of the tank. In the case of floating-roof tanks, the nominal capacity is defined as the volume from the underside of the roof deck up to the maximum floating position of the roof. The gross capacity (sometimes referred to as the total capacity) is the volume from the bottom of the tank up to its maximum, safe filling height. The net capacity is the volume of the tank contents between the low-liquid level (LLL) and the high-liquid level (HLL).

Tank dimensions. In general, tank heights do not exceed one and a half times the diameter. In cases where availability of land is not a constraint, it is justifiable to go for larger diameters in preference to height. As the tank height increases, wall thickness plays a more important role. Higher tanks also put a greater load on the soil. If the pressure becomes more than the soil-allowable bearing pressure, pile-supported foundations become necessary and are expensive. This concern is particularly applicable for poor soils. In general, tanks that are higher than 15 m are not commonly used in industry. ■

Editor's note: The material in this column was adapted from the articles referenced here:

1. Mukherjee, S., Understanding Atmospheric Storage Tanks, *Chem. Eng.*, April 2006, pp. 74–84.
2. Kenkre, P.D., Designing Atmospheric Storage Tanks, *Chem. Eng.*, March 2017, pp. 77–82.
3. Benz, A., Storage Tanks, *Chem. Eng.*, December 2019, pp. 34–37.